preserving readable Braille text. At some point after the dots on a given area of wheel **27** rotate out of reading aperture **39**, they come in contact with another physical structure that forces all the pins to a default position, after which the pins rotate back to the writing area (pin setting station **47**), where either the actuators are activated to shift the dots into the non-default position, or the actuators are not activated, allowing the corresponding dots to remain in the default position.

[**0076**] The default position may be either all pins raised from surface **33** (for external actuators) or all pins lowered from surface **33** (for internal actuators), the actuators thus being responsible for shifting selected pins to achieve the selected position of pin ends relative to reading surface **33** and reading aperture **39** (raised or lowered) to define the dots creating Braille characters. Utilizing the apparatus of **FIG. 6** (default position with all pins lowered) provides the benefit of not requiring actuator function for spaces and the like, any actuator sound the user may hear thus being associated with active production of text.

[**0077**] The dots are formed by pins **81** that are mechanically quite simple (see **FIGS. 6 and 8**, for example). Pins **81** are generally nail-shaped including a round shaft **83** with a rounded tip at one end **84** and enlarged head **85** (typically circular, for simplified mechanical behavior) at the other end **86**, head **85** having rounded edges. Rounded tips **84** of shaft **83**, when pins **81** are in the raised position, represents the Braille dot the user feels. Head **85** is the means by which the positions of pins **81** are controlled. Such pins are mechanically sturdy and reliable and inexpensive to manufacture.

[**0078**] **FIG. 6** illustrates embodiment **91** or the apparatus of this invention configured for application of selected devices illustrated in **FIGS. 7 through 22** in a wheel-based streaming Braille display utilizing an internal actuator design (it should be understood that **FIG. 6** is for purposes of illustration only, a usable Braille display having many more pins more closely spaced). The outer ring represents rotatable assembly **92** including rotating wheel **27** in which pins **81** are slideably maintained in openings **93** therethrough to reading surface **33** thereat. The inner ring represents non-rotating (static) actuator assembly **95** and includes structure **97** for mounting of actuators **49** (also represented in a linear array in **FIG. 7**), passive pin retention device **99** and passive default positioning device **101**. As wheel **27** rotates, pins **81** are set in position by the actuators **49** at station **47** of structure **97**, held in place by the passive retention device (or devices) **99** as the tactile display at surface **33** is streamed through reading area aperture **39** of housing **37**, and then returned to a default position (lowered, or retracted from surface **33**, in the FIGURE) by passive positioning device **101** to repeat the cycle. Passive retention can be extended any selected distance beyond reading aperture **39**. It should be realized that pins **81** could be left in their set position thereafter, thus eliminating the need for passive positioning device **101** to return pins **81** to a default position, employing, for example, bi-directional actuators. Actuator positioning closer to reading area aperture **39** will result in quicker response to user commands since it will take less time for pin position changes implemented at actuators **49** to rotate into the reading area.

[**0079**] Diameter of rotating wheel **27** in a particular embodiment is based on a number of factors. A smaller wheel is more compact (allowing for a smaller package for the entire display) and requires fewer parts (fewer pins **81**, for example). A larger wheel allows the reading area of surface **33** at aperture **39** to be less curved, allows more Braille cells to be displayed simultaneously at the reading area (which may be of particular value to users who read Braille with multiple fingers) permitting rapid re-reading of a Braille word before the word moves out of reading area aperture **39**. A larger wheel **27** will also exhibit slower wear (and thus longer useful life) since, as wheel size increases, individual pins **81** are cycled fewer times for a given amount of text displayed. The diameter of the wheel is preferably chosen so that an integer number of regulation size Braille (six- or eight-dot) cells with regulation spacing between cells can be precisely fit around the diameter of the wheel. Alternatively, having a noticeable discontinuity at one point on the surface of the wheel logically divides the displayed text into "lines", which a user of linear displays is accustomed to. In such an approach, it is desirable to select a wheel diameter so that the total cell count is some number familiar to readers, such a 40 or 80.

[**0080**] To implement a wheel-based display having an outer rotating assembly **92** and an inner non-rotating assembly **95**, wheel **27** of assembly **92** includes outer ring (or rim) **105** mounted on disk **107**, with shaft **109** controlling rotation centered through and attached by flange **111** with the face of disk **107** opposite the face on which the outer ring is mounted (shaft **109** being journalled for stabilizing rotation at journal **113** defined in structure **97** of assembly **95**). Rotating wheel **27** of assembly **92** is thus cup shaped, with open end **115** of the cup having non-rotating assembly **95** concentrically maintained therein (for example, by securing structure **97** to front wall **117** of housing **37**). The non-rotating components are installed at assembly structure **97** utilizing any known methods that provide satisfactory stability, and are precisely positioned within rotating outer rim **105** at their desired positions with respect to inner surface **104** of rotating outer rim **105** and thus pins **81**.

[**0081**] Braille cells have either three or four rows of dots (for six-dot or eight-dot Braille, respectively). Thus the display will need three or four rings (endless rows **121**) of axially arrayed pins **81**, all rings of pins rotating together about the same axis. Each row **121** has its corresponding actuator **49**, so either three or four actuators **49** are mounted adjacent to one another at station **47** of non-rotating assembly **95** at the interior of wheel **27**, each adjacent to a corresponding row **121** of openings **93**.

[**0082**] For both wheel-based and linear displays (discussed below with reference to **FIG. 23**), it is important that the timing of actuators **49** correspond closely with the position of pins **81** at station **47**. If motion is controlled by stepper motor **125**, for example, control logic **69** (see **FIG. 4**) can keep count of the motor pulses to keep track of the relative position of pins **81** and actuators **49**. However, given the challenge of selecting the correct initial pulse from which to start counting, and the risks associated with a failed motor action (causing the system to get out of step), a position registration system **127** (for example, periodic bumps or holes **129** in wheel **27** of the display apparatus through which light from source **131** shines on optical detector **133**) should be provided to send information to control logic module **69** constituting positive feedback on the relative position of the pin array and actuators **49**.